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Analog Based Routing Algorithm using Ant agents for MANETs (ABRAAM)

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Abstract

A mobile ad hoc network (MANET) is an anthology of wireless mobile hosts forming a short-lived network without the help of any centralized infrastructure. In such an environment, the reliable and shortest path finding between two hosts to transfer the payload is an extremely challenging task. The absence of a centralized infrastructure is a big problem in MANET where we cannot apply traditional routing algorithm used for standard wired networks. The three parameters tSignal Strength, Angle and Time of arrival are non-trivial parameters to decide the longevity and duration of a wireless link in a discovered route. A source node can analyze the reliability of a path and can establish an efficient routing algorithm for MANET by carefully measuring all analog measures and can predetermine the payload size which can be forwarded via that path.

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Keywords— MANETs, AOA, TOA, Signal Strength

1. Introduction

The basic idea behind *Antbased* algorithms for routing is the acquirement of routing information through route sampling using ant agents. These insubstantial agents are generated concomitantly and autonomously by the nodes, with the task to try out a footpath to an assigned destination. An ant going from source ***s*** to destination ***d*** collects Information about the quality of the path (e.g. end-to-end delay and number of hops), and, retracing its way back from ***d*** to ***s***, uses this information to update the routing tables at intermediate nodes. Ants always sample complete paths. The routing tables, called *pheromone tables*, contain for each destination vector of real-valued entries, one for each known neighbor node. These entries, the pheromone variables, are a degree of the goodness of going over that neighbor on the way to the destination. They are continually updated according to the quality of the paths sampled by the ants. The repeated and concurrent generation of ants results in the availability at each node of a bundle of paths, each with an estimated. While moving on the path, an ant evaluates this solution and deposits pheromone on its way. This pheromone trail will be used by the future ants to make a routing decision. The pheromone trail is calculated based on three important metrics which are Angle of Arrival, Time of Arrival and signal strength. These metrics are used to calculate the longevity of node in a network which ensures the reliability and consistency for routing and payload delivery process.

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1.1 General approaches

A substantial research effort has gone into the development of routing algorithms for MANETs. A number of routing algorithms have been proposed. Some of these are AODV[], DSR[] several other routing protocols Ant Net[] , ARA[] and AntHocNet[] . These protocols can generally be categorized as either *proactive* or *reactive* protocols. Proactive protocols form routes in the network persistently, even though there might not be packets to be transmitted between a certain set of nodes. Reactive (on-demand) protocols, on the other hand, attempt to institute multi-hop between pairs of nodes only when there are packets to be exchanged between these pairs of nodes. The nodes then forward data stochastically based on Pheromone values calculated from backward ants.

1.1.1. AntHocNet colony

AntHocNet is a hybrid routing algorithm, using ant agents to combine a reactive path setup phase with proactive path improvement efforts based on bootstrapping techniques. Bootstrapping is a characteristic of dynamic programming, in which nodes calculate the estimated quality of a path based on estimates made by neighboring nodes. This is the typical mode of operation in Bellman-Ford routing algorithms, to which table-driven algorithms like DSDV belong, and some reinforcement learning inspired approaches to routing, like SAMPLE. The idea of continuously improving existing paths is quite rare in MANETs, although it has been explored to some extent in.

1.1.2 HPPRAAM

HPRAAM a novel framework for MANETS which aim for parallel and guaranteed data transaction. HPRAAM uses Ant agents to find the optimal path between the source and the destination. This algorithm also finds the optimal load balancing routes between the two ends. Adding to this HPRAAM tries to reduce the total number of ants in the system. The payload delivery is combined with forward ant to discover newer routes when a node fails and backward ant is being used to send acknowledgment. The stochastic parallel routing needs more reliable paths to avoid all errors because of node failures.

2 Literature Survey

The general approach of route discovery, path updating, payload delivery and acknowledgment has been described in the following sections.

2.1 Forward ant structure

When a source needs to send a packet to a particular node, it first checks the cache for current routes. When no routes are known, it broadcasts Forward Request ANTS which are propagated through the network till it reaches the destination. This process can be compared to ants initially spreading out in all directions in search of food source. A forward ant at each intermediate node selects the next hop using the statistics stored in the routing table of that node or by rebroadcast. The next node is selected with a probability proportional to the goodness of that node which is measured by the amount of pheromone deposited on the link to that node. When a forward ant reaches the destination, it generates a backward ant which takes the same path as the corresponding forward ant but in opposite direction by using the dynamic stack available in forward ant.The backward ant updates pheromone values as it moves on its way to the source nodes.

The following ant structure is 32 bit header, the flag variable values and descriptions are given as

F=1 , Forward ant

P=0 , no payload is attached

Maxnumber of Modules – The number of modules totally going to be transferred.

AntID- Unique value for identification

HopCount – The current hop count value.

MaxHopCount- The maximum hop limit of a forward ant.

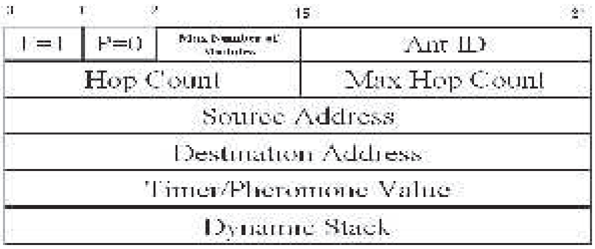


Fig 2.1.1 Structure of the Forward ant.

2.2 Forward Ant with Payload

Here forward ant is attached with the payload to discover the new routes whenever required or during the path failure and the AntID is used to avoid the duplicate packets and to avoid the traffic congestion. Here P=1 represents that a forward ant carries a payload .

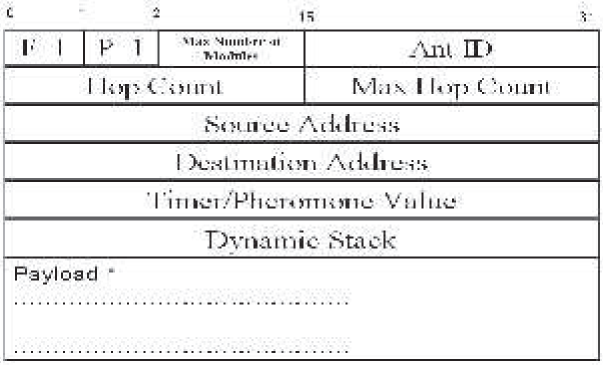


Fig 2.1.2 Structure of the Forward ant with Payload

2.3. Backward Ant

Upon arrival at the destination d, it is converted into a backward ant, which travels back to the source retracing the path. At each intermediate node *i*, coming from neighbor *n*, the ant updates the entry *i* T^i_{nd} which is the pheromone value indicating the estimated goodness of going from *i* over neighbor *n* to reach the destination *d,* in the *i*'s pheromone table. The way the entry is updated depends on the path quality metrics used to define pheromone variables. For instance, if the pheromone is expressed using the number of hops as a measure of goodness, at each hop the backward ant increments an internal hop counter and uses the inverse of this value to locally assign the value T^i_d which is used to update the pheromone variable T^i_{nd} .

$$T^{i}_{nd}=\alpha * T^{i}_{nd}+(1-\alpha)\, t^{i}_{d} \quad \alpha \in [0,1] \quad \text{------ (1)}$$

2.4. Backward Ant structure

The backward ant is configured with F=0 indicates it's a backward ant and P bit represents whether the ant has acknowledgment. P = 1 denotes that it's the acknowledgment for AntID received .

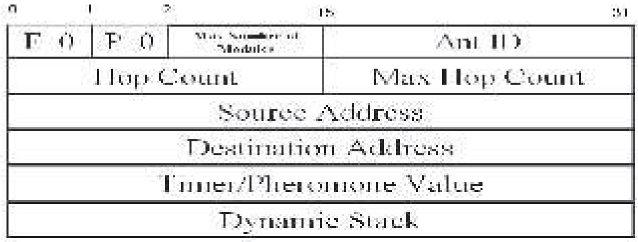


Fig 2.1.3 Structure of Backward Ant

3. Paper Organization

Section IV presents Route discovery, Path maintenance, Angle of arrival algorithm, Signal strength metrics and the way to use those metrics in routing algorithm .Section V presents the proposed work with the algorithm. Section VI deals with an example of the proposed work. Section VII deals with experimental results and Section VIII provides the conclusions.

4. Route discovery process

4.1. Route discovery

Route discovery is a process; a forward ant at each intermediate node selects the next hop using the information stored in the routing table of that node or by rebroadcast. The next node is selected with a probability proportional to the goodness of that node which is measured by the amount of pheromone deposited on the link to that node. The forward ant will take all analog metrics into account and will travel further, for instance when a forward ant finds the Angle of arrival deviates more than 80 degree then it finds that the neighbor may go out of the network soon or at any point of time in turn that path will become unreliable path so the forward ant will be killed there itself. This proposed approach has many advantages like limiting the number of forward ants and finding the optimal paths where the longevity of link is more.

4.2. Route maintenance

During the course of a communication session, source node s periodically sends out proactive forward ants to update the information about currently used paths and try to find new and better paths. However, the received proactive forward ant's paths are compared with the already stored paths by the destination d for achieving node disjointness .The destination d sends reactive backward ants only for the ants with the disjoint paths and others are ignored. The proactive ants follow pheromone and update pheromone tables in the same way as reactive forward ants. Such continuous proactive sampling of paths is the typical mode of operation in ACO routing algorithms. The proactive ants measure the signal strength and time of arrival to sample the path quality and that will be updated in pheromone table. The node table will have all analog metrics like Angle of arrival, Time of arrival and signal strength, in existing routing algorithms only delay related metrics has been taken to decide the probability of goodness, but this proposed approach measures analog properties of a device to determine the long existence path where more amount of data packets could be transferred via those paths, however a source node can decide the payload size could be transmitted a path without any failures.

4.3 Node Table

The Existing Node Table consists of four columns. The following Diagram Illustrates the Structure of the Existing Node Table.

Destination	**NextHop**	**Probability**	**Pheromone Value**
Node D	**Node A**	**0.90**	**1.24**
Node D	**Node B**	**0.10**	**0.01**

Fig 4.3.1- Existing Node Table structure

In the proposed architecture it is included two more columns, Such as Probability of Goodness and Angle of Arrival. Angle of Arrival which must be in the range of less than 80 and greater than -80, So that the nodes longevity could be predicted. Probability of Goodness is the average of Signal Strength and the inverse of Time of Arrival. This helps us to find out reliable and nearest Node. The node table will gets updated control packets like *hello* packets, *forward* and *backward ants*. The Probability of Goodness and Angle of Arrival will update the pheromone value, So that the final path will be long life and reliable. The formula for Probability of Goodness is given below.

The following is the Proposed Node Table Structure.

Probability of Goodness= (Signal Strength +(1/Time of Arrival))/2 ------ (2)

Destination	*Nexthop*	*Pheromone value*	*Probability of goodness*	*Angle of Arrival*
Node D	*Node A*	*1.25*	*0.91*	*-45*
Node D	*Node B*	*0.20*	*0.09*	*45*

Fig 4.3.2 Proposed Node Table

4.4 Angle of Arrival

The most widely used metric in MANET routing to find a “good” path between source and destination is Hop Count. But by using this method it doesn’t guarantee to find out reliable and long living path. It is evaluated as proposed approach against the previous work by implementing a modified version of the ACO protocol. In order to find the best route to the destination, where each node is assumed to be equipped with a digital compass. Also, each node classifies its neighbor into eight different zone ranges (d1…d8) according to their direction. This paper proposes a routing protocol based on the angles (directions) of the adjacent mobile nodes. Each pair of nodes that form a hop should ideally be moving in the same or similar direction, so the connection between the source and the destination will consist of a series of nodes that are moving in a similar direction. The Random Waypoint mobility model has been used in many studies the results show that the Random Waypoint mobility model is a good approximation for simulating the motion of vehicles on a road, but there are situations in which a different model is better suited. The angle of arrival of a signal is measured periodically and update in the node table. The new signal’s angle of arrival is compared with old one to measure the deviation; if eccentricity is more than 80^o then it indicates that the living time of the node will be very short so routing via that neighbor could be avoided to establish a reliable path.

5 Proposed Work

5.1. Angle Direction Algorithm

The following algorithm detects the angle of a arrived new signal and compares with old angle entries, the new signal could be taken if the angle ranges between *current angl*e – 80 to *current angle* + 80 , because the literature survey says that any new angle which doesn't bound in this limit may soon go out of the network. The measurement of angle of arrival could be done easily in hardware level itself, during path sampling like route discovery and path maintenance it is easy to detect that how long a node could be in the network, a node which moves fast surely will cross the angle boundary which is mentioned in algorithm, those nodes could be avoided in route discovery and path maintenance. This format of framing newer routes surely will reduce the overheads like node failure in a path and in turn it also reduces the packet retransmission. The following algorithm describes the working principal of angle of arrival based filtering.

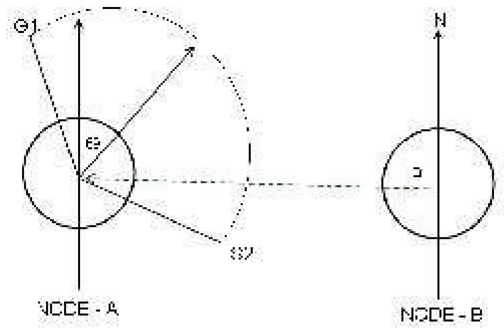


Fig 5.1.1 – Angle Direction Algorithm

If α [φ1,φ 2] subsequently establish a connection between A and B

Else do not establish the fragile link.

θ1 and θ2 are bounders of the angle θ; node A ***(receiving the request)***

α the angle of the node B ***(sending the request)***

```
Boolean In_range ( , θ)
{
      Boolean decision;
      Flage=0; θ1= θ - 80; θ2= θ + 80;
      If (θ1<0)
      {           θ1=360+ θ1; Flage=1;
                  }
      Else if (θ2>360)
      {           θ2= θ2-360; Flage=1;
                  }
      If (Flage ==1)
      {                     If (θ1< || θ2 >)
                                  Decision= TRUE;
                            Else
```

```
                    Decision= FALSE;
            }
Else
        If (θ1< && θ2 > )          Decision= TRUE;
        Else    Decision= FALSE;
Return (decision);
}
```

The following small piece of code RoutingAcoLookupSeenTable indicates how a new node reliability will be measured and parameters to be sent.

```
RoutingAcoHandleRequest(GlomoNode *node, Message *msg, int ttl)
{       :
        /* Process only if the packet is not a duplicate and in the angle range */
        if (!RoutingAcoLookupSeenTable( fwdantPkt->srcAddr,fwdantPkt->bcastId,
        &aco->seenTable) &&In_range( fwdantPkt->nodeAngle, node->nodeAngle) )
        :}
```

5.2 SIGNAL STRENGTH

Signal strength refers to the scale of the electric field at a position point that is a substantial distance from the transmitting antenna. It may also be referred to as received signal level or field strength. Typically, it is expressed in voltage per length or signal power received by a reference antenna. High-powered transmissions, such as those used in broadcasting, are expressed in dB-millivolts per metre (dBmV/m). For very low-power systems, such as mobile phones, signal strength is usually expressed in dB-microvolts per metre (dBμV/m) or in decibels above a reference level of one milliwatt (dBm). In broadcasting terminology, 1 mV/m is 1000 μV/m or 60 dBμ (often written dBu). Data can be sent successfully and rapidly when the received signal level is high.

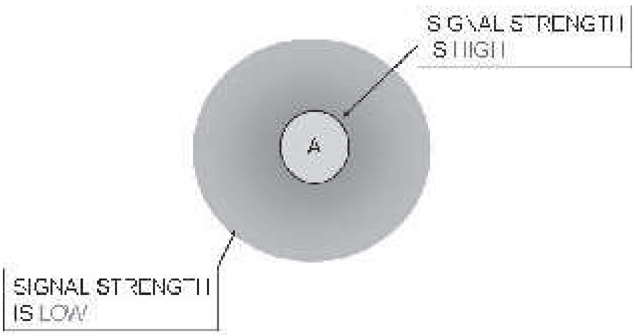


Fig 5.2.1 – Signal Strength of a Node

The signal strength is measured by RSSI (Received Signal Strength Indication). RSSI is generic radio receiver technology metric, which is usually invisible to the user of device containing the receiver, but is directly known to users of wireless networking of IEEE 802.11 protocol family. RSSI measurements are unitless and in the range 0 to 255, expressible as a one-byte unsigned integer. The maximum value, RSSI_Max, is vendor dependent. For example, Cisco Systems cards have an RSSI_Max value of 100 and will report 101 different power levels, where the RSSI value is 0 to 100. Another popular Wi-Fi chipset is made by Atheros. An Atheros based card will return an RSSI value of 0 to 127 (0x7f) with 128 (0x80) indicating an invalid value. There is no specified relationship of any particular physical parameter to the

RSSI reading. The 802.11 standard does not define any relationship between RSSI value and power level in mW or dBm. Vendors provide their own accuracy, granularity, and range for the actual power (measured as mW or dBm) and their range of RSSI values (from 0 to RSSI_Max). The subtlety of 802.11 RSSI comes from how it is sampled; RSSI is acquired during the preamble stage of receiving an 802.11 frame. To this extent 802.11 RSSI has (for the most part) been replaced with Received Channel Power Indicator. RCPI is a functional measurement covering the entire received frame with defined absolute levels of accuracy and resolution.
The data delivery to neighbor could be decided based upon signal strength also, ie) the signal strength is an important parameter to be taken while calculating the reliability of a path, however it is obvious that a good signal strength is more reliable than a poor signal strength path.

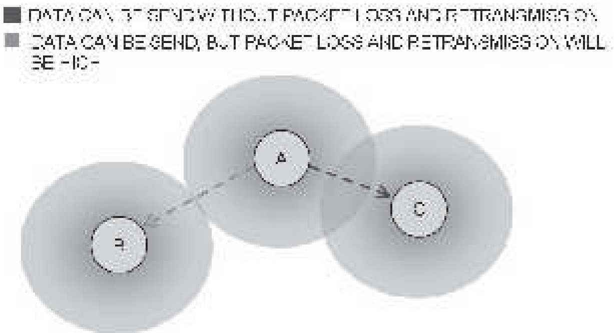


Fig 5.2.2 – Signal Strength of a Node

5.3 TIME OF ARRIVAL

Time of Arrival (TOA or ToA), also named Time of flight (ToF), which both means the travel time of a radio signal from a single transmitter to a remote single receiver. By the relation between light speed in vacuum and the carrier frequency of a signal the time is a measure for the distance between transmitter and receiver. However, in some publications the fact is ignored, that this relation is well defined for vacuum, but is different for all other material when radio waves pass through.

Similar to the TDOA technique, this Time of Arrival called technology only differs in the fact that it uses the absolute time of arrival at a certain base station rather than the measured time difference between departing from one and arriving at the other station. The distance can be directly calculated from the time of arrival as signals travel with a known velocity. Time of arrival data from two base stations will narrow a position to two circles and data from a third base station is required to resolve the precise position with the third circle when matching in a single point. There are many ToA-based localization systems, including GPS.

6 ABRAAM - Working Principle

The following figures show the working process of ABRAAM. It shows the structure of forward ant and the node table for each node when it is in process. For example 7 mobile nodes are taken and path will be defined for the source p1 to the destination p7. Sample path taken between p1 and p7 is { p1 → p2 → p4 → p6 → p7 }. The reliability between p1→ p2 is calculated based upon Angle of Arrival, Time of Arrival and signal strength. The angle of arrival is used to decide the life time of link, the publicized forward ant into a network will decide its travel based upon this angle of arrival, that is a node which receives a forward ant will forward that ant only if it ranges between current-80 to current+80. The signal strength and Time of

Arrival are the metrics taken for updating pheromone values, earlier the pheromone value is calculated based upon MAC delay and hop delay but here these analog parameters are also taken where it could be determined that how long a path or link is available.

6.1 Forward ant

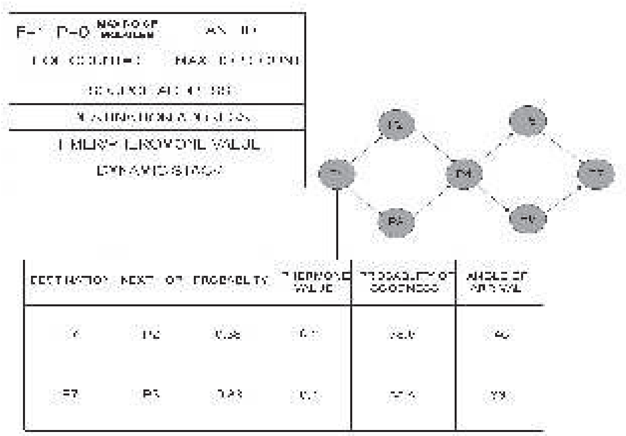


Fig.6.1.1 Proposed forward ant

Once the forward ant reached the destination node it will be converted as backward ant by swapping destination and source address .Hence there after backward ant will be travelling to exact opposite of forward ant to reach source, the forward and backward ants are not only used for route discovery and path updating but these ants are used to update pheromone values based of analog parameters to find reliable path. While Unicast Backward ant is updating the Node table and also updates both Angle of Arrival and Probability of Goodness. The probability of goodness is calculated by using signal strength and time of arrival, the signal strength direct proportionately taken and time of arrival inverse proportionately taken.

6.2 Backward ant

Backward ant is updating the path where angle of arrival, Signal strength and time of arrival all are taken into account.

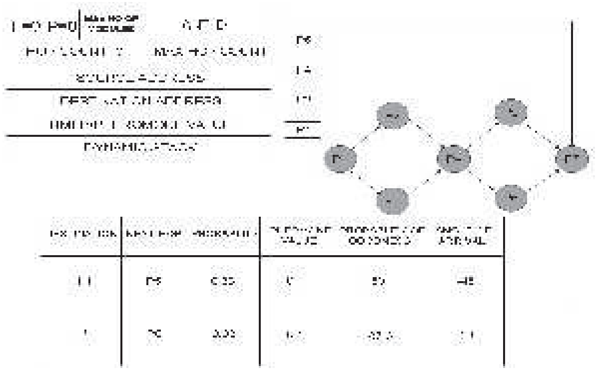
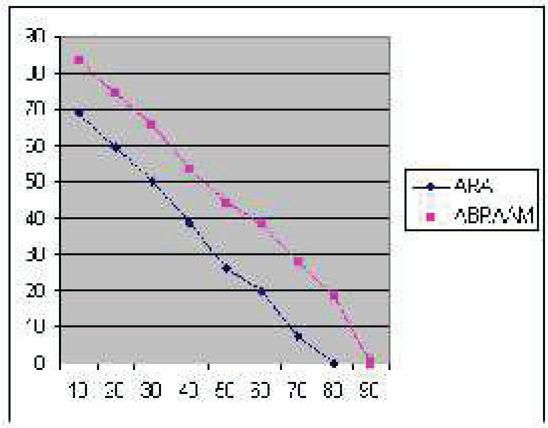


Fig.6.2.1 Backward ant

7. Simulation analysis

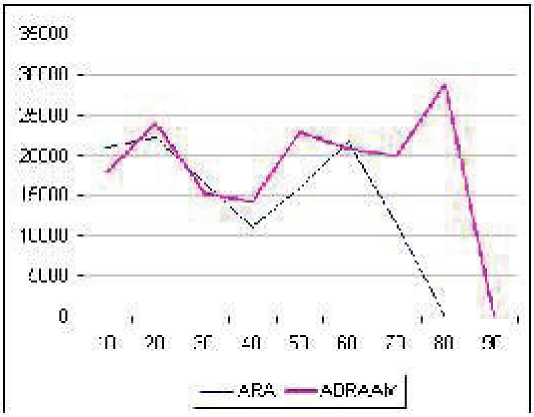
The simulation is executed with 90 mobile devices with the movement speed of 20 ms and 1000X1000 meter rectangle boundary , which is implemented a java based swan simulator. The Constant Bit Rate delivery method is taken and the simulation is implemented in Random waypoint mobility model. The analysis of the algorithm clearly establishes that data rate and life time of the path in ABRAAM is get increased when compared to the ARA. The following graph illustrates the contrast between ABRAAM and ARA concerning with Life Time of a path. The mobile movement speed started from 20 meters per second and slowly increased the movement speed until it reaches 90 meters per second.
The ARA and AntNet both will calculate pheromone value based on delay and time details but in ABRAAM outperforms ARA since AOA,TOA and Signal strength are taken in to account .



X –Axis: Mobile device movement in m/s.
Y- Axis : Duration of network in seconds.

Fig 7.1.1 – Lifetime of a path in ARA and ABRAAM

The graph given below shows the comparison between ABRAAM and ARA about the Data Rate of a path. The following analysis clearly indicates that ABRAAM outperforms ARA most of the time in terms of data rate. The total rate of different paths is shown here.



X- Axis : Movement speed of node in m/s.
Y- Axis : Data rate in BPS(Bits Per Second)

Fig 7.1.2 – Data Rate of a path in ARA and ABRAAM

Hence it is found that by using ABRAAM can find out the path with long life, high data transfer and most reliable path between the nodes. The second set of analysis has been taken as HopCount Vs Link duration in seconds and link average data rate. The following graph shows that hop count and link connectivity time are not directly proportional, for example path number 1 can reach the destination within 4 hop counts but it's life time is 13 seconds only at the same time path number 10 is in 10 hop count distance but the path will exists for 82.75 seconds,so whenever it is needed send more number of packets it is obvious that path number 10 could be selected irrespective of a small delay variation.

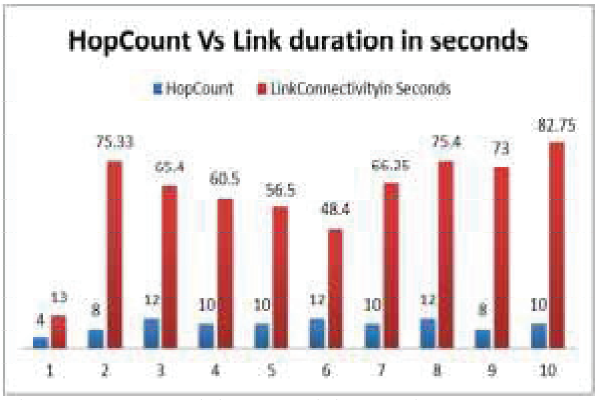


Fig 7.1.3 Average Link Connectivity Graph

The another important metric is data delivery rate , the overall average bandwidth of a link is higher even in more hop count paths, for instance path number 5's hop count is 5 slightly higher than the path number 4 but data rate is also higher , so whenever it is required to send more amount of data the path number 5 could be selected irrespective its hop count .

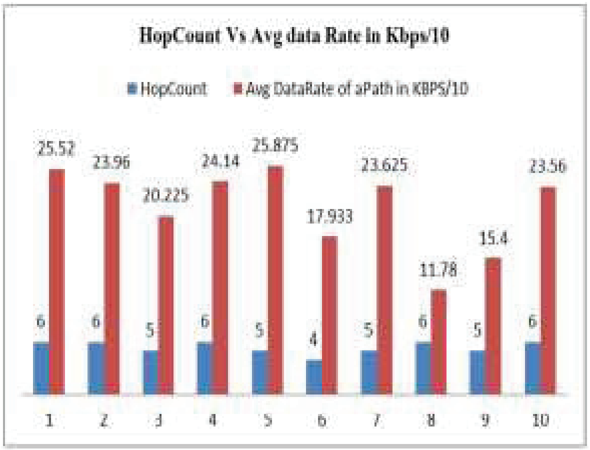


Fig 7.1.4 Average Data rate Graph

8. Conclusion and future work

The proposed work deals with three important parameters like Angle of arrival, Time of Arrival and signal strength rather than taking delay metrics alone. These parameters are showing a method to establish a reliable path between a source and destination node. The end to end delay, packet loss and number of retransmission of packets are enormously reduced here. And the maximum payload could be sent via a reliable path also is easily identified by the proposed algorithm. The main limitation of this work is to install an extra hardware to receive signal strength (RSS) and other calculations to find out long existing paths. This limitation could be easily overcomed by embedded system development with new hard wares.

References

[1] Ramkumar. K. R, GaneshKumar. M, Hemachandar. N, ManojPrasadh. D"HPRAAM: Hybrid Parallel Routing Algorithm Using Ant Agents for MANETS" IJET ,ISSN:1793- 8244,1793-8236,March 2009.

[2] Othman A. Al-amoudi, Mohamed S. El-azhari, Mike Woodward and Irfan Awan. "An Efficient Routing Mechanism based on Heading Angle" **On page(s):** 199 - 204 , **E-ISBN :** 978-0-7695-3639-2 , 26 June 009

[3]. Ramkumar. K. R, GaneshKumar. M, Hemachandar. N, ManojPrasadh. D,Nisha. M"ARRAAM:A Reliable Routing Algorithm Using Ant Agents For MANET", ISSN:1865-0929,1865-0937,ISBN: 978-3-642-02341-5 ,May 2009

[4] Chandra S., Shrivastava U., Vaish R. Dixit S. , Rana, M. "Improved-AntNet: ACO Routing Algorithm in Practice" **Print ISBN:** 978-1-4244-3771-9 May 2009.

[5]. M. Guine,, U. Sorges, and I. Bouazzi, "ARA-the ant-colony based routing algorithm for MANETs," in Proc. of IWAHN 2002, pp. 79-85, August 2002.

[6]. G. Di Caro, F. Ducatelle, and L. M. Gambardella, "AntHocNet: An Adaptive Nature-Inspired Algorithm for Routing in Mobile Ad Hoc Networks," Tech. Rep. No. IDSIA-27-04-2004, IDSIA/USI-SUPSI, Sep.2004.

[7]. Gianni Di Caro, Marco Dorigo, "AntNet: Distributed Stigmergetic Control for Communications Networks" Journal of Artificial Intelligence Research 9 (1998) 317-365.